ANNALS OF THE CHRYSENE FORMALISM

ORTHOGONAL REVIEW RECORD

Quantum Information Dynamics of the Source and the Placed Source

Lindblad Dynamical Scission, von Neumann Entropy Production, and Landauer-Bounded Quantum-Classical Transduction

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Declared review status

This is an AI-assisted simulated orthogonal review, not independently appointed human peer review. Separate mathematical and chemistry passes inform the revision. Concordance compares the manuscript, inherited report, computations and formal companion files. Revision responses describe prepared changes rather than unprovided author statements.

> **Scope of Review**
>
> The controlling input is Article 96's supplied `main.tex`. Its referee report, executable Python and two LaTeX companion dossiers are evidence to audit, not automatic certification. Channel algebra, continuous-time dynamics, thermodynamic work protocols and molecular realization are assessed separately.

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1 Source record and historical review

The original referee report is preserved unaltered as

`provenance/Article96_Prior_Referee_Source.tex`.

Its October 2026 metadata, Volume 1 Number 5 designation and verdict "Accept with Minor Revisions (Four Quantum-Information & Thermodynamic Enrichments)" are historical. Its assertions of exact verification and discharge of earlier targets are subject to the present audit.

`main.tex` SHA-256

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1.1 Earlier recommendations retained as provenance

The historical report requested four enrichments: entropy-production monotonicity, a finite-temperature Holevo formula, an energetic comparison with charging energy, and longitudinal pointer-state stability. These remain useful audit questions, but each requires the correct channel, thermodynamic protocol, noise model and physical interpretation. The inherited formal dossier's printed audit is not a substitute for compiling its actual listing.

2 Review architecture

> *M* — **Mathematical validity**
>
> Audit Lindblad transitions and coherence bounds, Kraus completeness, information capacities, work protocols, agreement-coordinate factorization and numerical evidence.

C — **Concordance**

Require agreement among definitions, equations, abstracts, status labels, executable code and compiled formal certificates.

H — **Chemistry and domain admissibility**

Separate ideal quantum channels and model energies from demonstrated molecular preparation, kinetics, baths and devices.

3 Mathematical review and revision response

3.1 M1 Repair the replacement channel and its hypothesis

Finding: major. With $d = 2^{l-1}$, the displayed Kraus terms satisfy $K_s = \Pi_s X^s/\sqrt{d} = |s\rangle\langle 0|/\sqrt{d}$. Hence $\sum_s K_s^* K_s = |0\rangle\langle 0|$, and the output is $\rho_{00} I/d$. This is not trace preserving: input $|1\rangle\langle 1|$ has output trace zero. An unprojected X-only twirl also is not a replacement map; it preserves the entire X-basis classical alphabet.

Revision response. Accept. Use independent dephasing and flip indices, or the equivalent matrix-unit Kraus family $K_{ij} = |i\rangle\langle j|/\sqrt{d}$, to obtain $R(\rho) = \mathrm{Tr}(\rho) I/d$. Complete dephasing and independent uniform contacts are explicit assumptions. A generator $\kappa(R - \mathrm{id})$ supplies the declared primitive relaxation, while entropy monotonicity uses the stated unital semigroup and its stationary reference. Molecular symmetry alone does not establish these premises.

3.2 M2 Correct the all-state coherence-scission claim

Finding: major. Let a be an absorbing admitted column state and b an absorbing rejected wash state. The pure superposition $(|a\rangle + |b\rangle)/\sqrt{2}$ has a cross-sector entry of magnitude $1/2$ forever under the bare jump generator; a diagonal Hamiltonian only changes its phase. Prior transit cannot damp coherence initialized directly between sinks. Moreover, entrywise decay is not by itself a trace-norm contraction proof.

Revision response. Accept. State the bare-generator result only after excluding initial admitted–rejected sink coherence. Prove the Hilbert–Schmidt estimate and its finite-rank trace-norm consequence. If a uniform all-input trace-norm bound is required, add an explicit sector-dephasing jump $\sqrt{\kappa} Q_{\mathrm{adm}}$ and derive its factorized cross-block evolution; this is an additional bath model, not a consequence of the original rates. Preserve the sink-superposition counterexample in verification.

3.3 M3 Make the source graph and retention calculation explicit

Finding: major. The source contains 15 labels but the inherited sink set omits the inactive κ_0 and κ_1 states. Both have zero outgoing rate, so the program's purported positive minimum is zero and its first rate assertion fails. A consistent minimal graph has seven absorbing labels and eight transient states: $\beta_n \to \beta_{n+1}$, $\beta_n \to \sigma_n$, and $\sigma_n \to \kappa_n$ for $n \geq 2$. Under the supplied early

substitution/export rates, the retained probability from β_0 is

$$p_{\mathrm{ret}} = \left(\frac{10000}{10001}\right)^2 \simeq 0.999800029996,$$

not the hard-coded value 0.998437.

Revision response. Accept. Define all edges, inactive states and sinks; derive the absorption probability from the stated generator and synchronize the emitted values. Retention is not density-matrix purity $\mathrm{Tr}(\rho^2)$. Column compression is completely positive and trace decreasing; normalization after successful selection is nonlinear. Only the complete sink-inclusive evolution is a CPTP channel.

3.4 M4 State work and information-capacity conventions

Finding: major. The relative-entropy identity is valid, but $k_B T(\ln d - S)$ is a cyclic degenerate-memory free-energy benchmark, not universal work for arbitrary Stark endpoints. Also a fixed-target replacement channel has zero communication capacity. The expression $m[1 - H_2(\epsilon)]$ describes the controllable target-labelled classical-to-quantum family, with $m = l - 1$.

Revision response. Accept. Specify the reservoir and endpoint Hamiltonians and account for control resources. Separate field gap, reversible average-work benchmark and actual work or heat. Derive the target-labelled family capacity using the uniform average output and the common conditional entropy; do not assign that positive capacity to a single fixed-target replacement channel.

3.5 M5 Correct threshold domains and generated values

Finding: moderate. For a nonnegative gap, the minimum threshold is

$$k_B T \max\left\{0, \ln \frac{1}{(1-\delta)^{-1/m} - 1}\right\}.$$

Without the maximum, the formula requires $\delta < 1 - 2^{-m}$. For five contacts at 300 K the correct 95% and 99% ratios are approximately 4.574499447 and 6.208581937, giving 118.2599587 and 160.5042589 meV and capacities 4.589214235 and 4.895569078 bits. Several inherited rounded assertions are false but were masked by the earlier execution failure.

Revision response. Accept. Use numerically stable logarithm/exponential expressions and correct emitted macros and tables. State threshold domain or clipping explicitly. Interpret one- and two-word reversal mixtures combinatorially; physical meso/chiral labels need the realization assumptions established in the revised symmetry analysis.

3.6 M6 Separate collective flips, longitudinal dephasing and local bit errors

Finding: major. The agreement permutation and global-flip factorization are sound. However $Z_k Z_{k+1}$ maps to registry Z_k and therefore destroys arbitrary registry coherence while preserving diagonal pointers. The displayed codeword-survival law is for local X bit flips, not Z dephasing. A pointer codeword has fidelity one under pure longitudinal dephasing.

Revision response. Accept. Retain exact noiselessness for the specified collective global-flip generator and diagonal pointer stability for longitudinal dephasing. Relabel the local-noise benchmark as independent bit-flip relaxation and avoid identifying its rate with an imported molecular phase-coherence time without calibration.

3.7 M7 Scope imported target and duality claims

Finding: moderate. The finite model does not discharge every earlier chemical or infinite-algebra target. "Dual" denotes complementary preparation modes here, not an established adjoint or inverse relationship. Arbitrary irreversible rates do not imply a thermodynamically free downhill process.

Revision response. Accept. Identify conditional finite-model resolutions, update cross-paper interpretations and remove blanket physical-discharge and zero-work claims. Keep the mathematical channel results distinct from thermodynamic and molecular realization assumptions.

4 Concordance review and revision response

4.1 C1 Replace unexecuted or overstated verification claims

Finding: major. The original Python script fails its rate assertion. It does not build all claimed superoperator, trace, absorption and trace-norm calculations. Retention is emitted as a string; its twirl test silently implements independent averaging rather than the printed channel. A counter set to 64^2 is not a test of 4,096 commutators. The verification LaTeX embeds a different older script with different dimension and buffer claims.

Revision response. Accept. Supply one coherent executed source, embedded listing, model-value file and audit. Include trace conservation, Kraus completeness, sink and channel counterexamples, source absorption, agreement actions and noise distinctions as actual tests. Preserve inherited files only as historical evidence.

4.2 C2 Replace the noncompiling formal certificate

Finding: major. Fresh Lean 4.24 compilation of the supplied listing fails all four proofs; the resulting audits contain `sorryAx`. Reflexivity does not establish the stated conjunctions, and the trace identity requires the definitions and arithmetic to be elaborated. Its displayed axiom-free log is not reproducible. The old dimensions and buffer claims do not certify the current registry theorem, and parity commutation alone does not prove general noiselessness.

Revision response. Accept. Preserve the inherited dossier and compile new finite certificates with an actual dependency audit. State exactly which matrix-unit, graph, bit-permutation and arithmetic facts are formalized. Do not present finite certificates as full proofs of semigroup analysis, entropy logarithms, capacity optimization, Landauer thermodynamics or molecular realization.

4.3 C3 Synchronize summaries and evidence boundaries

Finding: moderate. The abstract, figures, synthesis table, hypothesis register, conclusion and companion files must agree on replacement-channel assumptions, sink restrictions, cyclic work, target-labelled capacity and the distinction between flip and phase noise. Stale inherited values and unverified theorem-number attributions otherwise undermine the revised proofs.

Revision response. Accept. Align every summary with the revised source and generated values. Use primary analytic references for imported GKSL, entropy-production and thermodynamic facts. Label model retention and illustrative parameters accurately and match the OJS abstract to the final manuscript.

5 Chemistry review and revision response

5.1 H1 State the status of the source-state quantum embedding

Finding: major. The 15 labels combine substitution counts and phases. Their arbitrary coherences are not automatically accessible molecular quantum states. A microscopic preparation and observation model, conservation-law sectors and environment are required. Classical reaction rates do not identify a quantum bath or establish Markovianity. Retention is a model probability, not measured chemical purity; irreversible substitution and export do not generally occur at zero total energetic cost.

Revision response. Accept. Retain the rank-one-jump Lindblad embedding and its population correspondence as finite-model statements. Specify rate and bath assumptions, distinguish evolution from retained-column postselection, and describe retention values as model outputs. The proposed molecular application requires independently measured kinetics and a defined coarse graining.

5.2 H2 Do not infer complete quantum randomization from molecular symmetry

Finding: major. Inversion-invariant locants do not imply independent uniform registry draws, complete dephasing or zero quantum capacity. An X-only twirl preserves X eigenstates. The source's projected one-index sum is not the claimed replacement channel.

Revision response. Accept. Require the fully specified dephase-then-uniform-flip map as a modeling premise and supply a correct two-index Kraus representation. Zero capacity belongs to the replacement channel. It does not follow from inversion symmetry alone, and unequal physical rates need not define a replacement channel at all.

5.3 H3 Specify the thermodynamic preparation protocol

Finding: major. The identity $D(\rho\|I/d) = \ln d - S(\rho)$ is exact, but a work inequality needs consistent initial and final Hamiltonians and accounted controls. For an initially thermal uncorrelated reservoir and degenerate memory endpoints, a cyclic preparation can be bounded by $k_B T D$. A Stark field left on at the endpoint changes the free-energy difference. Reeb and Wolf [1] give an explicit reservoir framework and finite-size corrections; a heat theorem alone is not a work proof for arbitrary gate endpoints.

Revision response. Accept. State the cyclic, degenerate-endpoint work convention or use the general nonequilibrium free-energy change when endpoints differ. Do not equate energy gap, dissipated heat and required work. Replace known-state switching calorimetry by an ensemble-reset target with measured initial and final distributions and gate-work accounting. The five-bit pure-reset value is an ideal limit, not measured molecular dissipation.

5.4 H4 Distinguish a registry gap from a common Stark shift

Finding: major. The relevant bias is the difference $E_{\mathrm{opposite}}(F) - E_{\mathrm{target}}(F)$, governed by differences of dipoles and polarizabilities, rather than the absolute shift of either state. A common orbital shift may discriminate neither orientation. Fields of 0.1–0.5 $\mathrm{V\,Å^{-1}}$ correspond to 1–5 $\mathrm{GV\,m^{-1}}$

and require screening, nonlinear-response and stability analysis. Stark spectroscopy relates response to state-dependent parameters [2].

Revision response. Accept. Preserve the independent two-state Gibbs formula under equal degeneracies, adequate equilibration and calibrated local gaps. State the required conformer-specific response, environmental screening, contact-correlation and integrity measurements. Imported orbital-shift ranges do not establish the required registry discrimination.

5.5 H5 Keep the charging comparison conditional

Finding: major. $E_c = e^2/(2C_\Sigma)$ gives about 0.801 eV at $C_\Sigma = 10^{-19}$ F, but an sp^2/sp^3 label or graph boundary does not determine device capacitance. The latter includes electrodes, gate and environment. A registry gap below E_c does not by itself exclude leakage; bias, level alignment, coupling and broadening also matter. Single-molecule charging experiments illustrate those device-dependent requirements [3].

Revision response. Accept. Retain the arithmetic as a benchmark under an assumed capacitance and separately characterized weak-tunneling regime. Remove the universal no-leakage inference. Use the finite ratio of about $6.2k_BT$ for the 99% threshold rather than treating it as an asymptotic separation of scales.

5.6 H6 Separate noiseless quantum information from classical pointer stability

Finding: major. The agreement transform sends a collective global flip to $X_{\text{frame}} \otimes I_{\text{reg}}$, so the registry is noiseless for that specific generator. Longitudinal Z_kZ_{k+1} terms instead act on the registry and dephase its superpositions. They preserve only diagonal registry states. Noise-protected subsystems depend on the interaction algebra, not just molecular point-group labels [4].

Revision response. Accept. State collective-flip subsystem protection separately from longitudinal pointer stability. Include the restriction on Hamiltonian mixing and avoid claiming protection against arbitrary local or collective noise. Neither C_{2h} symmetry nor a scaffold alone establishes the required bath correlations.

5.7 H7 Correct the noise mechanism behind the fidelity benchmark

Finding: major. Pure Z dephasing leaves computational codewords unchanged, with fidelity one. The displayed decay expression instead describes independent registry bit-flip jumps with rate $1/(2\tau)$. Carrier transit, phase coherence and orientational flip relaxation may concern different degrees of freedom.

Revision response. Accept. Name the noise channel explicitly and use a flip-relaxation parameter for the codeword-survival formula. Keep the numerical timescale comparison illustrative; require noise spectra, correlations and measured rates to connect it to an actual molecular register. The mathematical formula does not demonstrate ambient-temperature molecular coherence.

5.8 H8 Match achievement claims to the model and identify empirical closure

Finding: moderate. Blanket discharge of physical quantum-scission, work and coherence targets exceeds the conditional finite-model results. The relevant material parameters are unmeasured in

the supplied package.

Revision response. Accept. Describe conditional model resolutions and gather the physical assumptions in the hypothesis register and discussion. The empirical target includes molecular identity and stacking, generator rates and retention, differential Stark gap and gate work, capacitance and bias window, and collective versus local flip/dephasing spectra. Matched controls should separate ensemble reset, known-state switching and noise protection.

6 Integrated disposition and verification scope

The numbered criticisms are accepted as corrections to channel definitions, theorem scope, numerical evidence and physical interpretation. The finite rank-one-jump correspondence, repaired replacement channel, entropy identity, target-labelled preparation family and agreement-coordinate factorization remain useful results. The stronger all-input scission statement requires a specified added bath; thermodynamic preparation needs a complete protocol. No physical experimental result follows from these repairs alone.

6.1 Execution and formal coverage

The replacement Python suite executes 93,858 explicit checks in each of normal and optimized modes, with byte-identical outputs: 93,767 exact predicates and 91 numerical comparisons. Ten negative controls are included. Tests cover the complete fifteen-state matrix-unit generator and sector dephaser, all matrix units of the 32-dimensional replacement map, sink and broken-channel counterexamples, absorption probabilities, reversal classes, corrected thermodynamic thresholds and capacity arithmetic, and agreement actions and partial-trace identities over site lengths two through eight.

The formal supplement freshly compiles 35 named Lean theorems for finite four-dimensional jump and replacement-channel identities, the 64-word agreement transform, and selected arithmetic consequences. The complete fifteen-state and 32-dimensional matrix-unit cases are exercised by Python; they are not silently attributed to the smaller Lean certificates. The Lean 4.24 dependency audit identifies 33 axiom-free theorems and two using the standard propositional-extensionality axiom `propext`; no `sorry` placeholder or added user axiom is used. A dependency audit accompanies the formal source. It does not formalize the general GKSL theorem, arbitrary-time semigroup estimates, entropy logarithms, capacity optimization, the thermodynamic second law or chemical realization. Those analytic and physical dependencies remain explicit.

The package supplies executed sources, matching embedded listings, hashes and audit records. The inherited verification and formal dossiers are preserved as historical evidence, with their failed execution claims explicitly superseded.

6.2 Focused closure

The focused mathematical and chemistry passes support all substantive revisions. Final chemistry completeness edits state the restriction on Hamiltonian mixing, identify initial and final reset distributions and a known-state control, and include field-integrity and structural characterization targets. These final edits are incorporated before release. This record is preparation for author review, not journal acceptance or experimental validation.

References

[1] D. Reeb and M. M. Wolf. An improved Landauer principle with finite-size corrections. *New Journal of Physics* **16**, 103011 (2014). https://doi.org/10.1088/1367-2630/16/10/103011.

[2] G. U. Bublitz and S. G. Boxer. Stark spectroscopy: applications in chemistry, biology, and materials science. *Annual Review of Physical Chemistry* **48**, 213–242 (1997). https://doi.org/10.1146/annurev.physchem.48.1.213.

[3] H. Park et al. Nanomechanical oscillations in a single-C60 transistor. *Nature* **407**, 57–60 (2000). https://doi.org/10.1038/35024031.

[4] D. A. Lidar, I. L. Chuang and K. B. Whaley. Decoherence-Free Subspaces for Quantum Computation. *Physical Review Letters* **81**, 2594–2597 (1998). https://doi.org/10.1103/PhysRevLett.81.2594.